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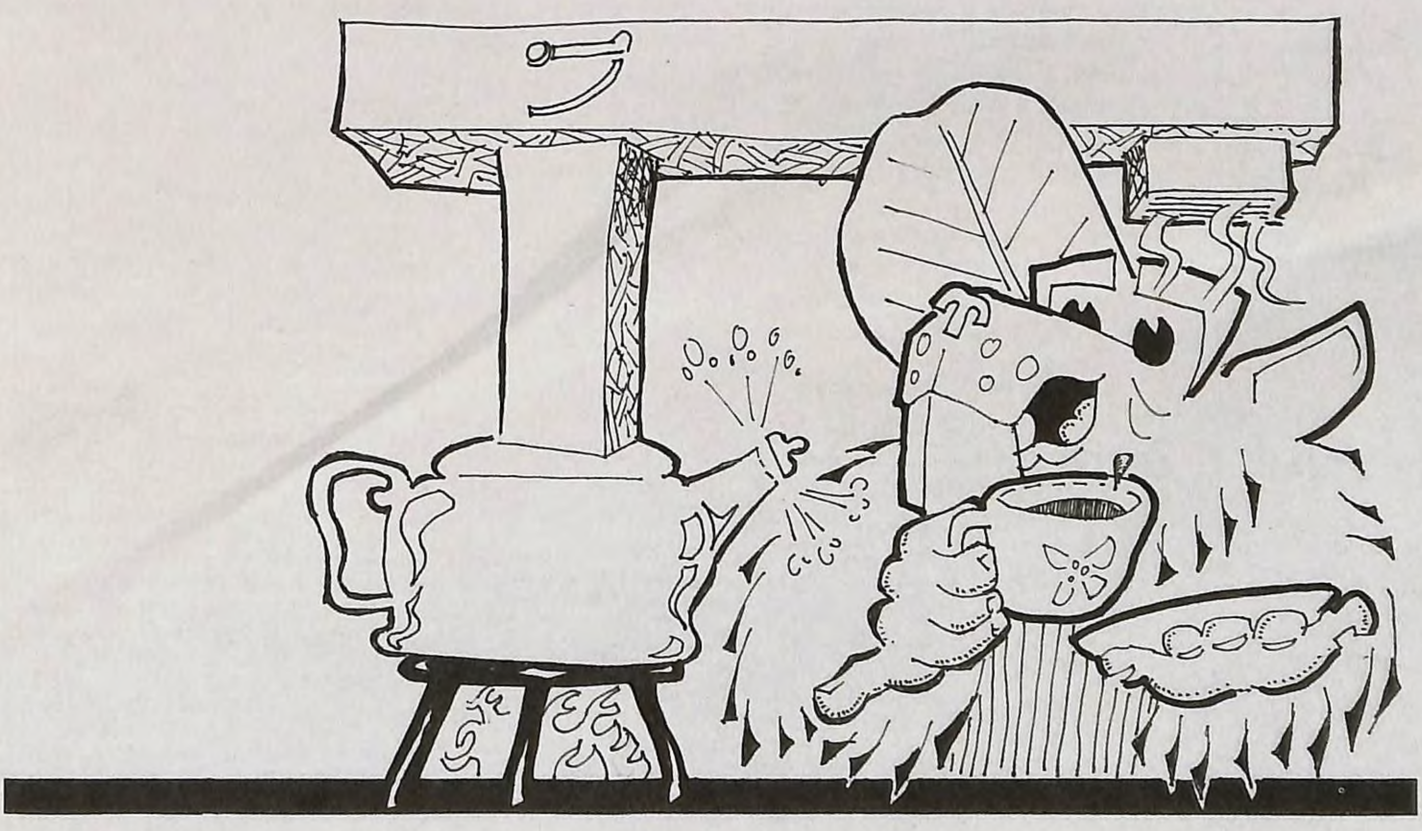

From The Editor . . .

Codes and standards, whether they be product, safety or installation standards, are generally drafted by committees that include a broad cross section of participants. In the construction industry, this includes designers, builders, researchers and materials manufacturers as well as building officials.

Building inspectors are an important part of the construction industry. They not only help to set standards for construction, but are important in helping to oversee the administration and implementation of the standards.

Our codes have been developed with the idea that 'everyman' be able to build their own shelter – hence the construction of a typical single-family dwelling can be done by the owner-builder. The prescriptive code requirements, which define minimum standards, have been crafted in a manner that spells out the key minimum criteria to follow, without need of professional assistance. In that case, the role of the local building inspector is to ensure compliance with the code.

Homebuilding is often the entry point for young people entering into an industry that does not automatically require technical qualifications. The building inspector often has to provide guidance to the novice builder – whether or not the participants like it or not.

However, the field inspectors themselves are often tradespersons that have moved from the site into administrative positions. Qualifications for the building inspectors are increasingly being raised, requiring more technical knowledge, given that they need to deal with a variety of building types and projects, and must understand building codes and applicable standards. But as these codes and standards are not static, and evolve, on-going continuing education for building officials is just as critical as it is for the designer or builder.

It came as a shock recently, in the context of discussions related to new energy code changes that are now being implemented, to learn that some local jurisdictions are not allowing their staff to attend workshops to learn about new code changes. It seems that some municipal administrators are not approving requisitions for their staff to attend workshops. In some cases, the unspent money in approved budgets may be used for executive pay bonuses (although one wonders why decently remunerated public sector administrators merit a bonus for doing their job). In other cases, such funds are retained as a contingency fund, and not spent.

I would like to believe that active discouragement of continuing education, especially for updates on current standards, is an isolated incident. Regrettably, I've heard from several sources that this may not be uncommon. So if that is indeed the case, then everyone in the industry should be very concerned.

If we don't have an informed public sector, then what does that really say about us? That it's OK to dumb-down our population? That staying current isn't really important? Most of us benefit from a push to study and upgrade ourselves. A group setting such as a formal workshop provides the added benefit of cross-fertilization of ideas and opportunity for discussion to achieve a higher level of understanding of the topic.

There is something fundamentally wrong when short-sighted management decisions can go unchallenged. It's bad enough that public policy decisions have been cutting back on education support, research and closing down libraries. But discouraging continuing education, in the name of fiscal responsibility is a dumb way to set priorities. In an information age, it is simply stupid.

Richard Kadulski,
Editor

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Combination Mechanical Systems

Combination mechanical systems that provide both space heat and hot water in a single system have gained a significant market share for small and efficient homes. Reliable market statistics are not available, but some industry sources estimate that more than 30,000 combination systems are being installed annually in the Ontario new home market alone. Many of those systems are going into homes that typically have peak space heating loads of 51,000 BTU/hr (15 kW) or less (including a 40% oversize "safety" factor that is traditionally added to the calculated design space heating load).

Historically, combination systems started when an air handler fan coil was attached to a conventional water heater. The water heater provided the hot water for the fan coil that provided space heat when heat was called for. Some of these systems were site built while others were commercially marketed. However, these early systems used conventional water heaters, which are inefficient.

The inherent efficiency of integrating mechanical systems was highlighted more than 25 years ago through the Advanced Houses initiative in Canada. In the early 1990s, ten demonstration houses were built across the country. These high performance homes were designed as a demonstration of state-of-the-art energy efficient and environmentally responsible technologies.

In addition to showcasing new products and building technologies, the advanced houses had to meet an energy target at least 50% lower than the R-2000 standard of the day (roughly equivalent to today's R-2000 energy target). They still had to be marketable, as the houses had to be sold to recover construction costs – the subsidies available to the teams only addressed the incremental costs for technical support and monitoring.

Space heating loads were reduced through attention to improved building envelopes, but even with the much reduced envelope heat losses compared to conventional housing of the day, they still required some supplementary space-heating. Although the technologies incorporated in the construction varied between the advanced houses, all teams incorporated combination mechanical systems. In all cases these combination systems were designed and assembled as prototype site-specific systems.

Based on an extensive review of the technologies and monitoring feedback, the integrated mechanical systems were identified as the most significant innovations used in the advanced houses. It was recognized that they offered the great potential for significant reduction of energy consumption and greenhouse gas emissions in homes.

Following that initiative, NRCan provided technical support to the industry to help the commercialization of integrated mechanical systems, and also for the development of a new standard: CSA P.10 – *Performance Of Integrated Mechanical Systems For Residential Heating And Ventilation* in 2007. This set the standard for the real-world, actual installed performance of home mechanical equipment that, in a single package, combines space heating, domestic water heating, and ventilation (with heat recovery). To date, there is only one manufacturer (NY Thermal Incorporated) that has a tested product that meets the P10 standard.

Combination systems only combine forced warm air space heating and domestic hot water heating. This type of system usually consists of a fan coil installed with ductwork, and a small pump that circulates water from the water heater through the fan coil.

Combination systems are not currently regulated under Canada's Energy Efficiency Regulations. However, they are tested in accordance with CSA P9.11. This Standard describes the test procedures, test set-ups, and calculations required to determine the performance, capacities, energy consumption, and overall efficiency of gas-fired and oil-fired combined space and water heating systems. [*CAN/CSA-P.9-11 - Test method for determining the performance of combined space and water heating systems (combos)*]

CSA P.9.11 testing yields a "thermal performance factor" that combines measures for both space heating and water heating.

While any space heating system must be capable of providing its rated space heating output when required, space heating systems only need to provide their peak heating output for at most a few days during the year. However, overall combination system performance is still dominated by space-heating loads because the duration of the space heating loads are much longer.

Combined Space and Domestic Water Heating System

The efficiency of a combined space and water heating system is measured by a value called the Thermal Performance Factor (TPF), which is the sum of annual thermal outputs delivered by the combo for space heating and water heating divided by the total thermal energy inputs needed to produce each component load.

Water heaters and fan coils must be matched. At present, 27 systems made by five manufacturers, have been tested in accordance with CSA P9.11 and are listed on the Natural Resources Canada Office of Energy Efficiency database. The TPF varies from 0.73 to 0.95.

The list is accessible on the Internet: *http://oee.rncan.gc.ca* and look for searchable product list.

Achieving high performance in part-load space heating tests is far more important than at full rated output when calculating the overall system performance.

The CSA P.9.11 standard recognizes that systems will operate under part-load conditions most of the time and it generates space heating efficiency ratings based upon direct tests with full and part-loads.

To achieve maximum efficiency, the flue gases need to be cooled. The water vapour in the flue gasses is condensed to extract the maximum heat – which preheats the incoming cold water. However, it can be challenging to make the water heater condense in the space heating mode because the return water temperature from the space heating coils will generally be warmer than the city water inlet temperature that the system heats when providing potable hot water.

Condensing water heaters offer the potential to provide much more energy efficient combination systems. Factory engineered combination systems make it possible to optimize combos and their controls to deliver high performance systems that condense in most operating modes. They can vary the supply water temperature for the space-heating mode that will significantly improve overall system performance. Engineered packaged systems that control water heating and air handling functions together can condense almost all the time. Some manufacturers of on-demand water heaters are starting to develop components as well as packaged combination systems.

Intelligent residential combos may be one way that reasonably priced zoned heating systems can be used. Because they utilize hydronic fan coils, there are no minimum or maximum air temperature rise issues -- as there are in a gas-fired furnace -- that could impact equipment performance or safety certification. Nor is there a need to maintain a minimum airflow across the air handler.

Using Water heaters for Efficient Space Heating

High performance results can be achieved where efficient components are well matched and the operating system intelligently controls both the water heater and air handler together.

Water heater performance can change as the flow rate (i.e. the water heating load) changes. Changes in water heating energy performance as a function of load are not fully captured within standardized Energy Factor (EF) ratings for water heaters. The term EF only applies to stand-alone water heaters. When a conventional water heater is going to be used in a combo system, different performance testing needs to be done, and that is outlined in the P9.11 standard.

One of the advantages of a tankless (on-demand) water heater is that it can provide different supply water temperatures for water heating and space heating loads. It can also vary the water temperature it supplies for different space heating loads. This is key to providing high efficiency water heating and very efficient part-load space heating.

Using a variable speed pump in the air handler can also improve energy performance, as it can supply water with variable supply temperatures because on-demand water heaters can do this more easily. However, variable speed pumps are not common in air handlers at present.

CSA P9.11: Thermal Performance Factor

The thermal performance factor (TPF) is the key energy performance value in the CSA P.9 standard. It combines ratings for space heating and water heating performance and takes a weighted average of the two to generate this value. Space heating part-load performance is the key factor in the overall performance rating.

Recognizing whether a demand is for space or water heating and responding differently is important. Water supply temperatures for space heating need to be kept low whenever possible to keep return water temperatures low, and thus maximize condensing of flue gases.

As space heating is typically the dominant load in Canadian homes, the overall performance

weighting for combination systems is dominated by space heating. Part-load space heating test results have the most important weighting in determining the composite space heating performance rating, and therefore TPF.

During CSA P.9.11 efficiency tests, intelligent controls strategies are allowed to function. For instance, the control can start operating in space heating mode with a lower temperature supply to the air handler and a lower fan speed. These can be stepped up repeatedly if the load has not been met within a specific time period. Alternately, controls using load sensing approaches such as outdoor reset controls may provide similar performance improvements and can be simulated during tests. This is particularly important during part-load space heating efficiency tests.

CSA P.9.11 assumes that the daily domestic hot water load is the same as the standard water heating load that is currently used to determine the Energy Factor (EF) ratings for residential gas and oil fired water heaters. ☼

Building code changes:
energy efficiency

The new energy efficiency regulations for the National Building Code (section 9.36) came into effect in BC at the end of December 2014. Other jurisdictions will be implementing the full document shortly. There are some important changes that are going to affect designers and builders.

Energy requirements have been set to reflect the severity of the climate. Climate zones are defined in terms of number of degree-days – in 1,000-degree day steps. This matches the approach taken by the National Energy Code for Buildings, which applies to larger buildings, as well as the ASHRAE standard that has been widely used for large buildings.

Zone 4 is less than 3,000 degree days ˚C (south-western coast of BC); Zone 5 (3,000-3,999 DDC – Kelowna Windsor); Zone 6 (4,000-4,999 – Toronto, Halifax); zone 7 (5,000-5,999 – Calgary, Winnipeg).

Effective Thermal Resistance of Wall Assemblies

Up to now, nominal insulation values were used to define required insulation. However, we know that the actual R-value for an assembly will vary, depending on how the assembly is built, the type of materials used and how thermal bridging is dealt with. That is why the code now requires that contributions from all portions of an assembly – including heat flow through framing elements – need to be taken into account. So the thermal resistance values are now listed as effective R-values.

Required effective R-values vary by climate zone and whether or not an HRV is installed in the house.

Thermal Characteristics of Above Ground Opaque Assemblies (Table 9.36.2.6.A)

Assembly	Climate Zone (Heating Degree Days ˚C)				
	Zone 4 < 3,000	Zone 5 3,001 to 3,999	Zone 6 4,000 to 4,999	Zone 7A 5,000 to 5,999	Zone 7B 6,000 to 6,999
Ceilings	6.91 (39.23)	8.67 (49.2) *6.91 (39.23)**	8.67 (49.2)	10.43 (59.2) *8.67 (49.2)**	10.43 (59.2)
Cathedral ceilings	4.67 (26.5)	4.67 (26.5)	4.67 (26.5)	5.02 (28.5)	5.02 (28.5)
Walls (2x6 @ 16")	2.78 (15.78)	3.08 (17.48) *2.97 (16.86)**	3.08 (17.48) *2.97 (16.86)**	3.08 (17.48) *2.97 (16.86)**	3.85 (21.86) *3.08 (17.48)**
Floors over unheated space	4.67 (26.5)	4.67 (26.5)	4.67 (26.5)	5.02 (28.5)	5.02 (28.5)

All values are *effective* R-values
Values in brackets are imperial
** Values in Italic are applicable when an HRV has been installed*

To calculate effective R-values, several options are presented within the code and supplemented with appendix information. See sample calculation in side-bar. Although on first look the effective R-values may seem intimidating, once builders and designers find some assemblies that work for them, it will not be an onerous requirement. What this approach does do is allow builders and designers to optimize their construction details, and even use new assembly combinations. It will be easier to show building officials how alternative assemblies are code compliant.

Insulation must be continuous across the entire envelope, but this does not mean continuous insulation across face. Rather, this means that the insulation must be applied fully to building components such as partitions, chimneys, fireplaces, and columns and beams that are embedded along exterior walls. The insulation must be installed snugly with no voids.

In general, where there is thermal bridging:
Effective R < Nominal R value
Where there is NO thermal bridging:
Effective R = Nominal R value

Thermal bridging through studs and joists are dealt with by the calculation method for determining effective R-values.

Garages are clearly identified as being exterior spaces, even if the attached garage is insulated and heated. Thus the assemblies between the conditioned part of the house and garage must have the same effective R-value as the exterior wall.

Although we don't see too many masonry fireplaces on exterior walls today, they still are being built. Now, these will have to be insulated. However, the insulation on the masonry fireplace or flue on an exterior wall can be reduced to no less an effective R-value of 55% than that required for the exterior wall.

Full height basement wall insulation is now required. The top of the foundation wall above grade is treated as a foundation wall only if the height above grade is not more than 2 feet (600 mm). If a foundation wall is much higher, then it must be treated as an above grade wall.

Unheated floor slabs must be insulated a minimum 1.2m horizontally or vertically down from its perimeter, with a thermal break along edge of slab that has a minimum R-value that is 50% of required insulation.

Mechanical, plumbing or electrical system components (such as pipes, ducts, conduits, cabinets, chases, panels or recessed heaters) within or parallel to an exterior wall assembly must be insulated to the same effective insulation level as required for the wall. This means that running a heating or ventilation duct, or a water line in an outside wall or through the attic above the insulation, with only a couple of inches of rigid insulation, is no longer acceptable.

There are no limits on glazing area for houses. The rationale for this was that the total window area for most houses is within 15-23%, so requiring calculations for all houses would not be justified in a minimum standards code.

Calculating Effective R-values

To calculate the effective R-value, you need to know how the construction assembly is built, as all layers are taken into account. Repetitive framing elements must be considered. In a typical stud wall, 23% of the surface area is accounted for by the studs. Framing and cavity percentages are listed in a table (A.9.36.2.4.(1)A for typical as well as advanced framing practices, with spacing between 12 to 24".

The simplest way to determine effective R-values with conventional framing assemblies is to use Table A-9.36.2.6.(1)A. Select the framing option: 2x4 or 2x6 at 16 or 24" spacing with R-19, R-22, or R-24 batt insulation. The table sets out what the effective R-value of the framing portion is, taking into account the framing factors. The final columns then set out how much more is required to achieve the required affective R-value – this would then take into account all the other materials in an assembly.

Example:

2x6 frame wall: 16" stud spacing, R-19 batt insulation ("R-20"), OSB exterior sheathing and conventional stucco cladding; ½" gypsum board on interior.

From table A-9.36.2.6.(1)A, the effective R-value of the stud wall portion itself is RSI 2.36 (R-13.4). The table then lays out the minimum nominal thermal resistance to be made up by the other layers in the assembly to meet the minimum required. If we are looking at a house in zone 6 (i.e. 4-5,000 DD°C) which requires a minimum effective R-value of 3.08 (or R-17.48) (assuming there is no HRV) then the other materials in the wall assembly will have to add up to RSI 0.72.

In our example, the R-value of the other layers of the assembly are as follows:

Interior air film	0.12
½" gypsum board	0.076
Poly vapour barrier	-
½" OSB sheathing	0.108
Weather barrier	-
Stucco	0.018
Exterior air film	0.03
Total	0.352

Total effective R-value of this wall assembly is thus 2.712 (15.39). Thus for a house located in zone 6, this assembly does not meet the required thermal resistance.

A variety of options would need to be reviewed to determine a combination of changes that would achieve the required R-value. Options to achieve the required effective values could include use of materials with higher insulation properties including continuous exterior insulation, use of HRV, installing exterior cladding with a rain screen (as the air space in a rain screen cavity can contribute a significant benefit).

Air tightness

The code has always required airtight construction, but it mainly spelled out how to identify airtight materials. With the new focus on energy efficiency, addressing building airtightness is important since air leakage is a major factor in heat loss, as well as contributing to durability issues. It is also a major factor in deterioration, as warm air leaking out through the building envelope can lead to condensation within the assemblies.

The code does not require airtightness testing. Rather, section 9.36 lists a number of common details that need to be dealt with and that will achieve improved airtightness, but testing of the building is not required.

The air barrier must be continuous across all control and expansion joints, junctions between different building materials and assemblies, and around penetrations through all building assemblies. Fireplaces must be airtight

Heating, Ventilation and Mechanical

The energy efficiency requirements for mechanical systems in some cases exceed minimum energy efficiency requirements set out by other regulations, and those were made on the basis of availability of equipment with a reasonable market penetration already.

One major change requires that all space heating and domestic hot water heating equipment must be kept inside the conditioned space of the house. The practice in some areas of placing this equipment in the garage will no longer be acceptable, because the garage now is considered to be exterior space, even if it is an insulated and heated space. The only exception is for that equipment designed to be placed outside.

Ducts located outside the conditioned space are a major source of heat loss through the ductwork itself. Ducts outside the conditioned space are still permitted, but must be air sealed and insulated to the same effective R-value as is required for the walls. The intention is to discourage duct placement on the exterior, and keep them within the conditioned space, however, it is recognized that on occasion some designs will necessitate the placement of ducts in less than ideal locations, and even outside the conditioned space. Where that is the case, to minimize heat loss, the ducts must reduce heat loss.

Ducts are known to have significant air leakage unless attention is given to careful air sealing of all duct joints, which are significant sources of leakage. That is why it is now required that any ducts carrying conditioned air that are located outside the conditioned must be air sealed. The air sealing cannot be done by fabric "duct tape" which has been identified as not being suitable for use on metal ducts.

Every exhaust duct or opening to the exterior must have a motorized damper or backflow damper, except for those intakes or exhaust ducts that must remain open as covered by other regulations (such as combustion air for some equipment). The exception is a house located in a climate with less than 3500 DD°C. Motorized dampers must be a type that remains in the open position if the damper fails.

HRV supply and exhaust ducts do not require dampers, since the HRV is assumed to be operating continuously.

Heat pumps with a supplementary heater must have controls that prevent the operation of the supplementary heater at times when the heat pump can supply the full heat load.

Similarly, where there is both heating and cooling system in the building, the controls must prevent both systems from being activated simultaneously. In other words, the cooling system should not be activated to compensate for the overheating by the space heating system.

Hot Water

The first 2 m of piping from a storage tank or heater must be insulated with pipe insulation. If the hot water piping system has recirculation, the entire hot water system must be insulated. ☼

Canadian Housing Information Centre Closes

The current Canadian government seems to have abandoned the housing industry – one of the major industries in the country. Contrary to all the PR bafflegab, their actions speak louder than the words that emanate from the bloated government 'communications' departments.

Canada Mortgage & Housing Corporation (CMHC) has been the federal government's housing agency. When it was established more than half a century ago, it was the vehicle for funding social housing as well as undertaking housing technical and social research into housing issues. Their activity was driven by the needs of a fast developing post-World War II economy.

Today, in sync with government policy, the research has for all intents been eliminated – there is only a token group there so that the corporation cannot say they have shut it down, but the limited staffing doesn't leave enough critical mass to do any meaningful work. The housing research function is a statutory obligation, written into the legislation governing CMHC.

The latest news leaking out from staff at CMHC's national office is that the Canadian Housing Information Centre (CHIC) is to close this spring. CHIC is CHMC's corporate library. It is the most extensive housing information source in Canada, serving CMHC staff, consumers, builders, developers, academics and industry decision-makers.

The collection is made up of both CMHC and non-CMHC material, consisting of approximately 80,000 books, reports and publications; 180,000 images in the Photo Library and more than 3,000 scientific and technical periodicals in the fields of housing and community development.

Ostensibly, library contents are to be digitized and the books to be put into storage. Just another government library to be dismantled, stuffed into boxes, with contents no longer usable. Digitizing libraries is a massive task, not to be taken lightly, and not done quickly, which leads to the suspicion that a lot of material will be totally lost to users. This includes research papers that may contain kernels of information useful for future researchers.

Without access to previous research reports and documents, there will be a lot of wasted effort and resources 'reinventing the wheel'. The fundamental step in any research study is to do a literature search to see what others have done previously and then fill in gaps and build on prior knowledge. All our technological advancement today is based on that principle. That is why libraries are so important. They are repositories of that accumulated knowledge.

CHIC has been a vital element for the housing industry. Although the library is at CMHC's head office in Ottawa, its materials have been accessible to anyone in Canada through interlibrary loans, allowing students and professionals from anywhere in Canada to access their valuable information.

Digitizing the library does not solve access issues. Because of the immensity of the task, it is inevitable that material will be culled, and at best only a portion will be digitized. And contrary to appearances, digitized material is not accessible to all. When a technical failure occurs, the library contents could become totally unavailable. Pull the plug, and it disappears. Just look what's happened at the National Research Council. When their system was shut down in the summer of 2014 by a cyber attack, nothing was available from their libraries and databanks. Six months later, there is still no indication when they will be available again. This sort of thing doesn't happen to hard copies.

As the federal housing agency, over the years the corporation was the go-to agency for the Minister whenever foreign delegations came to Canada looking for housing information and expertise.

With increased interest in Canadian housing technology, CMHC set up an international division to help Canadian housing exporters tackle foreign markets. It helped Canadian companies decipher foreign regulations, which despite worldwide rhetoric about free trade have actually become barriers to trade.

The evidence was that the efforts at opening doors in various countries, Canadian housing exports, and the Canadian housing brand that grew out of initiatives such as R-2000, were having success. Canadian housing exports, from construction materials, to components, to entire housing units, were growing. However, when the government policy came out a couple of years ago to cut staff, international housing export support was axed in its entirety. This cutback in industry support was unique to the housing industry, since government support to other industry sectors has continued (think of oil and gas, aerospace or IT sectors).

It's not as if these activities cost a lot of money. CMHC has become a major financial arm (and source of funds) of government – it does provide a vital function providing mortgage insurance. But that is done on a very profitable basis – the *net* revenue of the corporation is in the range of ***$1.6 Billion*** – even before the closure of CMHC research, international or CHIC.

Why is the Canadian government abandoning the housing industry? ☼

Canadian Home Builders' Association

Technical Research Committee News

Effective R-value Calculators

Canadian Wood Council Wall Thermal Design Calculator

The Canadian Wood Council has developed an on-line tool to provide builders and designers with prescriptive wall assembly solutions complying with national energy code efficiency requirements. While the focus is complying with 9.36 of the National Building Code (NBC) for houses and with the 2011 National Energy Code for Buildings (NECB) for larger buildings, the wall assemblies will be a handy reference to comply with any code that requires an *effective* R-value.

http://cwc.ca/resources/wall-thermal-design/

Owens Corning Thermal Calculator

Owens Corning has developed an effective R-value calculator that uses the calculation methodology, material values and framing factors listed in the National Building Code of Canada. The calculator is not limited to walls, but will also do calculations for roofs, foundation elements, and cold floors.

The user defines how the assembly is constructed, and the individual material thermal R-values used in the calculation can be seen by downloading the results file. To start the calculation, the user inputs the location, so the degree-days for the location are provided. However, the location information is not used – the required R-value is not provided. Although the calculations require location information, information on whether or not the proposed assembly would comply with the code is not provided.

In addition, Owens Corning has been conservative in their approach when it comes to the thermal resistance values for vented air spaces created by vertical strapping on exterior wall assemblies (i.e. rain screen air spaces). A major flaw of their calculator is that it does not attribute a thermal resistance value for the air gap created by the wood strapping or one for any material outboard of such a vented space. However, it is recognized that these air spaces do contribute some insulation value, as does the cladding outboard.

In some locations, for assemblies that may be on the limit for compliance, the rain screen cavity will provide additional insulation value that can be used to show code compliance. In BC, the Building and Safety Standards Branch has issued a bulletin to confirm this, and states that for walls, a 9.5 mm rain screen air space has an RSI value of 0.15. The cladding outboard of the rain screen cavity is then used with its thermal resistance value.

At the time that NBC 9.36 was developed, air cavities less than 13 mm were not considered, which is why 13 mm was the narrowest listed. This value is the result of the same scientific principles that were used to establish the values for air cavities listed in Table A- 9.36.2.4.D.

http://insulation.owenscorning.ca/builders/calculators/thermal-project-calculator

New Radon Rough-in Requirements in BC

The potential for high radon levels can be challenging to evaluate before construction and a radon problem may only become apparent once the building is completed and occupied.

That is why the building code requires that, in new construction, provision be made for future radon remediation. This requires that a gas permeable layer be placed under the basement slab house, with a pipe under the slab that is capped inside the house, and labelled as a radon pipe.

The intent is to make it easier to install a radon remediation system if needed. Radon mitigation systems are proven to reduce the likelihood of adverse health effects from radon, such as lung cancer.

Concerns have been expressed that that the location and condition of the rough-in have not always been suitable for future connection of a radon mitigation system. In addition, there have been some anecdotal stories that some homeowners, not understanding what the radon pipe is, or the label having been lost, treated the capped pipe as a plumbing rough-in.

As a result, the BC Building and Safety Standards Branch, in consultation with industry and health professionals, has decided to make changes to the existing BC Building Code requirements. Effective December 19, 2014, BC Building Code provisions for the rough-in for a subfloor depressurization system now require the installation of a radon vent pipe which extends through the house and terminates outside the building.

The new requirements will provide a more adaptable substructure for future radon mitigation and require the designer to account for routing of the radon vent pipe during the design stage. This change applies to Part 9 dwelling units and buildings containing residential occupancies where a floor assembly separates conditioned space from the ground.

The most common and efficient radon mitigation method is soil depressurization. A soil depressurization system requires:

☞A gas permeable layer under the basement floor that allows for the movement of soil gases between the ground and the air barrier system;

☞A radon vent pipe then extends to the exterior of the building and terminates in a safe location; and

☞A radon vent pipe mechanically assisted by a fan installed along the pipe, to depressurize the area below the basement floor air barrier system and exhaust soil gases outside the building.

The new BC Code requirement will be the installation of the vent pipe through the house to terminate above the roof, just like plumbing vents. Extending a pipe through the building to the exterior after construction has been finished can be problematic if the design did not account for radon mitigation. It was considered that providing for a radon rough-in during initial construction would add a small cost and effort at the time of construction to reduce a much larger cost of retrofitting a radon mitigation system after construction is completed.

The Code will not require installation of a fan during initial construction, although designers should consider the future installation of a fan (which will require access and electrical supply) somewhere along the radon vent pipe.

The new requirements provide added benefits of improved sub-slab drainage and integrity of the air barrier system.

Resources on Radon and radon remediation:

British Columbia Ministry of Health *health.gov.bc.ca*

RadonAware, British Columbia Lung Association *radonaware.ca*

The Canadian Cancer Society: *cancer.ca*

CMHC and Health Canada publication: Radon: A Guide for Canadian Homeowners (2007) *publications.gc.ca*

Health Canada publication: Guide for Radon Measurements in Residential Dwellings (Homes) 2008 *publications.gc.ca*

Radon – Reduction Guide for Canadians *hc-sc.gc.ca*

BC Building & Safety Standards Branch *www.housing.gov.bc.ca/building*

Energy Answers

Rob Dumont

We continue Rob Dumont's Directives for a Decent Energy Efficient Home. In the last two issues we presented the first 16 points. Here we present the next three points. The conclusion will be presented in the next issue of Solplan Review

16. Efficient Water Use

Domestic Hot Water Use. The domestic hot water (DHW) load is usually the second largest energy load in houses after space heating. To reduce the DHW load, the following measures are recommended:

1. Low flow showerheads. The US EPA has a WaterSense™ program to identify water saving showerheads. To qualify, the showerheads must use less than 2.0 US gallons per minute (7.6 litres per minute) at a water pressure of 80 psi. Some brands have an integral shut-off valve in the showerhead that allows you to save water while you are soaping yourself. They are sometimes called "Navy Showers".

2. Energy Star clothes washer: use the most efficient model Tier III model available. They will have a modified energy factor (MEF) of 2.4 or higher, and a water factor (WF) of 4.0 or higher. A complete product listing is accessible on the NRCan website: *http://oee.rncan.gc.ca.* Search for the searchable product list which includes products that do not meet the Energy Star qualification.

3. Energy Star dishwasher: use the most efficient model available. A complete product listing is accessible on the NRCan website: *http://oee.rncan.gc.ca.* Search for the searchable product list which includes products that do not meet the Energy Star qualification.

4. Drain water heat exchangers recover the thermal energy leaving the house when hot water is being used, like in a shower. As water is used, it is replenished by incoming water that gets warmed by the hot water being flushed down the drain, so the incoming water to the heater is warmer. There are no moving parts – this is simply a substitution of a portion of the drain stack.

However, these units must be installed vertically, so they will not be useful if there is no basement, or if used for basement plumbing.

5. Extra insulation on the water heater storage tank, and pipe insulation on the hot water lines. By adding R-28 insulation to the outside of the electric tank type water heater and placing pipe insulation for the first meter of both the cold and hot water pipes to and from the water heater, I reduced the standby heat loss from 100 watts to 25 watts on a 40-gallon electric water heater tank.

A better alternative is to choose a well-insulated tank type water heater. One manufacturer in the U.S. offers non-metallic electric tanks that are well insulated and have Energy Factor (EF) values in the range of 0.9 to 0.94. A Canadian company that rents water heaters chooses that brand in large part because of the low maintenance requirements and absence of the need for anode rods. In California, commercial water heater tanks must have a minimum insulation value of -R16.

Be very careful when adding an insulation blanket to a fuel-fired tank water heater, because blocking the airflow through the combustion chamber and air dilution inlet could result in carbon monoxide production. An alternative for gas-fired water heaters is to use tankless (on-demand) water heater.

6. Locate the water heater close to the end uses in the kitchen and bathrooms. This reduces the large slug of cold water in the pipes that must travel from the water heater to the end use.

7. In larger, multi-storey houses with a bath-

MEF: measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.

WF: Water Factor (number of gallons needed for each cubic foot of laundry). A lower number indicates lower consumption and more efficient use of water.

Directives For A Decent, Energy Efficient Home

1. Design
2. Lot Selection
3. House Shape
4. Design for flexibility
5. Trees
6. Garage Type
7. Contractors
8. Windows
9. Thermal mass
10. Insulation levels
11. Air tightness and mechanical ventilation with heat recovery
12. Low-emission materials
13. Space Heating/Cooling and Domestic Water Heating
14. Renewable Energy
15. Cooling/Air Conditioning
15. High Efficiency Lighting.
16. Efficient Water Use.
17. Energy Star Appliances
18. Safety
19. Durability
20. Think multiple uses, low impact materials

room or kitchen a large distance from the water heater, it may be desirable to install a small (cottage-style) booster water heater that is well insulated in the remote location so hot water is available in seconds (rather than minutes). As an alternative, you could use an electric pump and a return water line to the regular water heater from the hot water tap in a remote bathroom to allow hot water to be rapidly available. Put a timer on the pump switch to make sure that the pump does not run for more than the short time needed to bring hot water to the tap.

If the hot water lines include a recirculation system, then the entire hot water line system must be insulated.

8. Use smaller diameter plumbing wherever possible. The volume of a ¾" pipe is twice that of a ½" pipe of the same length. The volume of a ½" pipe is about twice that of a 3/8" pipe. If a half-inch diameter pipe will do, you only need to run half the amount of water until it gets hot than if the pipe were ¾". Low flow fixtures such as low flow shower heads and aerating taps would allow smaller diameter pipe to be used compared to conventional fixtures because of the lower flow rate requirements.

9. High efficiency water heater. Check the NRCan website: *http://oee.rncan.gc.ca* which lists all equipment available in Canada, or Energy Star Web Site. http://www.energystar.gov/certified-products.

10. Some municipalities, including Saskatoon, now require a check valve and an expansion tank on the cold water supply to the house. If the bladder in the expansion tank fails, very high pressures will develop in the plumbing system as cold water enters the tank water heater and expands. Periodically check the temperature and pressure relief valve on your tank water heater to make sure that it will function. A plugged relief valve can be very serious, and has resulted in the explosion of water tanks. A video showing the results of an electric hot water tank explosion can be seen at *www.appliancevideo.com* and look for a video titled "Results of an Exploding Electric Hot Water Tank."

Make sure that the outlet from the temperature and pressure relief valve can drain to the sewer and not on expensive floor coverings.

11. Cold Water Use. For qualifying products, have a look at *www.epa.gov/WaterSense/products/*.

i. Toilets are usually the single largest water users in a house. Low water use toilets should be chosen. Some jurisdictions have already mandated toilets with 6 litres or less per flush. Some toilets use a dual flush mechanism with either 3 or 6 litres per flush.
MaP is a VOLUNTARY testing program that has tested more than 3,000 products for effectiveness. Results are published in an accessible database found at *www.map-testing.com*

ii. For extra water saving, consider a Japanese style combined sink and toilet. These units have a sink on the back of the toilet. Wastewater from the sink flows into the toilet tank and is used for flushing the toilet. One drawback is that the sink normally only provides cold water.

iii. Choose low water use vegetation on the outside of the house using native plant materials.

I have used almost all of the above water conservation measures in my house in Saskatoon, and in 2012 the house used 140 cubic metres (37,000 U.S. Gallons) of water for three adults (my wife, daughter and I), a good-sized vegetable garden, and a small area of grass on a 6000 square foot (558 square metre) lot.

Conventional houses in Saskatoon average about 306 cubic metres of water use per year or 2.2 times as much as our consumption. Water charges currently amount to about $2.07 per cubic metre in Saskatoon plus monthly service charges. At the current water price, we have an annual saving of $344 from the water conservation measures. Over a 25-year mortgage, the water savings amount to about $8600.

17. Energy Star Appliances (refrigerator, freezer, dishwasher, and clothes washer) are recommended. Look for Tier III Energy Star Appliances for the best efficiency. *http://housewares.about.com/od/majorappliances/f/CEEtier-certification.htm*

Front-loading clothes washers tend to have higher spin speeds and remove more moisture than top loading clothes washers, resulting in less energy used for clothes drying. Consider a drying rack in addition to a regular clothes dryer. With a drying rack you save energy and the clothes do not wear out as much.

The drying rack also adds moisture to the house air, which may be a welcome benefit for that time of year where some added indoor humidity is welcome. However, it may be a problem in milder maritime climate zones or if there are other large moisture sources in the house.

As the bathrooms should be continuously vented through an HRV, moisture generated from a drying rack can be vented to outdoors with some heat recovery by the HRV (but never vent the dryer through the HRV!).

An outdoor clothesline is also an option for part of the year. A conventional electric clothes dryer is usually the largest consumer of electrical energy of all the appliances in a house. Many homeowners like to have the clothes washer and dryer located in a bathroom close to the bedrooms of the house or adjacent to a hallway close to the bedrooms. To conserve space, use a stacked washer and dryer combination.

Reduce phantom energy loads (the electrical loads that draw power even though the device is nominally off) by having separate, wall mounted electrical switches and outlets to control devices like your cable box, satellite dish, internet router, and TV.

In my house, over a one-year period, the electricity consumption for LAME (Lights, Appliances and Miscellaneous Electricity excluding space heating and domestic hot water) amounted to 4086 kilowatt-hours (kWh). We have a full complement of white appliances including an electric oven and range, Energy Star refrigerator, separate Energy Star chest freezer, Energy Star dishwasher, and Energy Star Front Loading clothes washer.

The average household in Saskatchewan uses 8340 kWh a year for LAME according to

Consortium for Energy Efficiency (CEE) is the US and Canadian consortium of gas and electric efficiency program administrators formed more than twenty years ago to achieve lasting and verifiable energy efficiency. CEE has been influencing markets to accelerate the development and availability of energy efficient products and services for lasting public benefit.

The Consortium for Energy Efficiency leverage the ENERGY STAR® program, by setting out and offering specifications with performance thresholds (tiers) that meet and exceed the ENERGY STAR level for the various appliance categories covered.

CEE background information and resource documents are available on their web site: *http://www.cee1.org*

	Conventional Existing Houses in Saskatchewan	Dumont Residence (built in 1992) Measured data for 2012	% Reduction for the Dumont Residence
Annual total purchased water consumption (cubic metres per year) (City of Saskatoon data)	306.0	140.0	54%
Annual water consumption for domestic hot water (cubic metres per year)	82.1	40.8	50%
Annual Electricity Usage for Domestic Hot water (kWh/yr) (SaskEnergy data)	4546	2254	50%
Annual Electricity Usage for lights, appliances and miscellaneous uses excluding space heating and water heating(kWh/year) (Statistics Canada data)	8340	4086	51%
Annual Total Energy Consumption [purchased energy for space heating, water heating, lights, appliances and miscellaneous electricity per square metre of floor area] (kilowatt-hours per square metre per year)	300	56.7	81%

Table 1. Comparison of Energy and Water Consumption of Dumont Residence in Saskatoon with Conventional Existing Houses.

Statistics Canada. At the current electricity price of 13.8 cents per kWh we have saved about $549 a year compared with the average Saskatchewan house by using less than half as much electricity for LAME.

In addition to the Energy Star appliances and entertainment products, we use compact fluorescent lamps, and LED lamps in our house. The exterior light fixture on our most frequently used exterior door is a motion sensor activated light. We also have a detached garage that is insulated (but not heated), and normally we do not use a block heater to keep the engine warm for starting. In sustained cold weather we use a timer on the block heater so that the block heater is only on for about 3 hours overnight. (In Saskatoon in January, the average outdoor temperature is about -18°C and temperatures will occasionally fall to about -35°C or colder.)

Over a 25-year mortgage life, the savings on LAME in our house amounts to $13,725.

If electric heat is used for space heating, the savings would be less, because the heat released from conventional appliances is mostly useful for space heating during the heating season. However, remember that that little bit of excess heat contributes to overheating in the summer.

In my house, in our cold climate, the space-heating season extends only from about October to May. From June through September, there is normally no auxiliary space heating required, as the energy conservation features in the house along with small heat gains from the appliances and lights provide sufficient heat. A small amount of heat is also provided by passive solar gains from windows. Heat released from appliances and lights during that period just adds to the cooling load.

If electricity must be used for space heating, also consider an efficient heat pump. Heat pump technology has improved, so that today's cold climate heat pumps will provide net benefit even during very cold weather.

18. Safety. If you have any combustion appliances in the home or if you have an attached garage or you allow tobacco smoking in the house (definitely not recommended), install a carbon monoxide sensor in the living space. Placing smoke detectors in each bedroom in addition to the ones mandated by the building code is also a good idea. Remember that the building code requirement is a minimum standard, and not a best practice standard.

The National Building Code requires CO alarms within 5 meters of all bedroom doors if any combustion appliance or an attached garage is present. Manitoba now requires smoke and CO alarms in all bedrooms in these instances. Ed.

What is a gas permeable layer?

It is a material that is not less than 4" (100 mm) of clean granular material containing not more than 10 % of material that will pass a 4 mm sieve.

Alternative Permeable layer

The code requirements for permeable layers below basements have been a problem for some because there are regions in the country that have limited sources of clean granular materials at reasonable cost.

One enterprising company has developed an interesting alternative. Plasti-Fab Ltd., a manufacturer of expanded polystyrene insulation products, has developed a sub-slab depressurization panel that also provides floor insulation.

The insulation panel, called Radon Guard™ (patent-pending) allows for sub-slab depressurization soil and gas removal while at the same time providing insulation and a capillary break between the ground and the air barrier. The panels have grooved interconnected channels on the underside that provide for free airflow.

A CCMC Evaluation Report (13698-R) confirms that the interconnected channels on the underside of Radon Guard insulation provide the required means to direct soil gas to a radon gas mitigation system.

The Radon Guard insulation panels installed under a concrete slab allow for the collection of radon gas within the sub-slab space so that it can then be exhausted through a radon mitigation system. These insulation panels are a code compliant one-to-one replacement for a 100 mm thick layer of granular material, the prescriptive solution required by building codes.

Information: *www.plastifab.com*

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